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ABSTRACT

This study sought to determine whether an individual learns relatively better from pictures than from words and whether such information can be applied to the learning of prose materials. A paired-associate learning task consisting of both pictorial and verbal items from which different types of learners could be reliably identified was developed. Based on this instrument, repeated classifications of a fourth-grade sample were found to be consistent. When applied to the comprehension of prose materials, the instrument served to identify those children for whom self-generated visual imagery constituted an effective organizational strategy. (TO)

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Technical Report No. 250

# STRATEGIES IN READING COMPREHENSION: II. INDIVIDUAL DIFFERENCES IN LEARNING FROM PICTURES AND WORDS

by

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Report from the Research Component Conditions of School Learning and Instructional Strategies

Wisconsin Research and Development
Center for Cognitive Learning
The University of Wisconsin

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## Statement of Focus

Individually Guided Education (IGE) is a new comprehensive system of elementary education. The following components of the IGE system are in varying stages of development and implementation: a new organization for instruction and related administrative arrangements; a model of instructional programing for the individual student; and curriculum components in prereading, reading, mathematics, motivation, and environmental education. The development of other curriculum components, of a system for managing instruction by computer, and of instructional strategies is needed to complete the system. Continuing programmatic research is required to provide a sound knowledge base for the components under development and for improved second generation components. Finally, systematic implementation is essential so that the products will function properly in the IGE schools.

The Center plans and carries out the research, development, and implementation components of its IGE program in this sequence: (1) identify the needs and delimit the component problem area; (2) assess the possible constraints—financial resources and availability of staff; (3) formulate general plans and specific procedures for solving the problems; (4) secure and allocate human and material resources to carry out the plans; (5) provide for effective communication among personnel and efficient management of activities and resources; and (6) evaluate the effectiveness of each activity and its contribution to the total program and correct any difficulties through feedback mechanisms and appropriate management techniques.

A self-renewing system of elementary education is projected in each participating elementary school, i.e., one which is less dependent on external sources for direction and is more responsive to the needs of the children attending each particular school. In the IGE schools, Center-developed and other curriculum products compatible with the Center's instructional programing model will lead to higher student achievement and self-direction in learning and in conduct and also to higher morale and job satisfaction among educational personnel. Each developmental product makes its unique contribution to IGE as it is implemented in the schools. The various research components add to the knowledge of Center practitioners, developers, and theorists.

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Ms. Divine-Hawkins is now at the Office of Economic Opportunity, Washington, D. C.

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## Abstract

An instrument was developed for determining whether or not an individual learns relatively better from pictures than words. Based on this instrument, repeated classifications of a fourth-grade sample were found to be quite consistent. Moreover, when applied to the comprehension of prose materials, the instrument served to identify those children for whom self-generated visual imagery would constitute an effective organizational strategy.

# I
# Introduction

In a recent investigation Levin, Rohwer, and Cleary (1971) demonstrated that children could be reliably classified on the basis of whether they learned relatively better from pictures as opposed to words. Following the administration of a paired-associate list which contained both unlabeled picture pairs and aurally presented word pairs, elementary-school children were grouped according to whether their paired-associate recall resulted in relatively large or relatively small picture-word differences. It was found that these initial classifications of the children tended to be fairly stable over a two-day period when a second (parallel) paired-associate task was administered. More recently Mallory (1972) reported a similar finding based on different materials and classification procedures.

The observed stability of individual differences in the Levin et al. (1971) study was actually the serendipitous by-product of an experiment with an unrelated objective conducted by Rohwer, Ammon, Suzuki, and Levin (1971). Thus, while the Levin et al. result turned out to be interesting in its own right, the original experiment had not been planned to answer questions directly related to individual differences. All analyses in the Levin et al. paper were admittedly post hoc, and all conclusions were admittedly speculative. Such is not the case here. Based on the previous findings, we sought to demonstrate that individual difference-related picture-word effects obtained on a paired-associate learning task are not only reliable, but also applicable to more school-like activities such as reading.

Specifically, the dual objectives of this study were (a) to develop a paired-associate learning task (ideally, group administered) consisting of both pictorial and verbal items from which different types of learners could be reliably identified and (b) to determine whether such information could be applied to the learning of prose materials.

## II
## Experiment I

### Method

#### Construction of the Learning Task

From a population of over 100 line-drawings of objects (animate and inanimate) familiar to young children, 64 were selected to create two 16-pair lists. Only pictures with labels for which there was consensus (based on a pilot-testing of first and sixth graders) were included. The 64 pictures were nonsystematically assigned to the two lists subject to the following three restrictions: (a) there were approximately equal numbers of animate objects in each list; (b) objects that were conceptually similar (e.g., knife-fork, bus-truck) were assigned to different lists; and (c) objects whose labels were acoustically similar (e.g., bat-cat, tire-fire) were assigned to different lists.

Within each 32-item list, the 16 pairs were nonsystematically formed subject to the following two restrictions: (a) objects that were obvious associates of one another (e.g., bus-tire, doll-house) were assigned to different pairs and (b) objects were paired only if it was possible to construct a plausible interaction between the two.[1] Following this, eight of the pairs in each list were randomly designated as picture pairs and eight as word pairs. Item pairs were then randomly ordered within each list such that different item types (pictures or words) appeared in the first two list positions as well as in the last two; in addition, no more than two consecutive pictures or words were permitted. These measures were taken as precautions against primacy, recency, and response-set effects, respectively. Four such "random" orders of the items were constructed, two for study trials and two for test trials (stimulus terms only), in order to prevent serial learning of the responses. Successive revisions and replacements of items (suggested by item analysis) as well as revisions of the instructions and procedures were conducted to improve the task's parallel-forms (separated by 24 hours) reliability. This included the addition of a third study-test cycle (actually a repetition of the first study-test trial items).

Both the pictures and typewritten labels of the pictures were photographed and mounted on slide transparencies (one adjacent pair of pictures or words per slide). Pictures and words were placed in their predesignated positions within the 16-pair, mixed-list sequences.

In the initial pilot testing of the instrument, both first and sixth graders had been tested individually. However, the final version seemed to lend itself to group administration. Accordingly, (a) only children in Grades 4-6 were included as Ss and (b) individual-S response booklets were used on each test trial. In these booklets were printed the labels of the 16 stimulus terms, with Ss required to supply the missing response terms.

#### Procedure

The Ss were run in groups (intact classrooms). After distributing the response booklets, E informed Ss of their task. Items for the first study trial of Form A were then projected onto a screen at the front of the room, 5 sec. per pair. Following the last study pair, Ss (having been reminded to work quickly) were allowed 1 1/2 min. to complete the first page of their (three-page) response booklets. Two additional study-test cycles were then provided. The next day E returned unannounced and administered Form B of the task in similar fashion.

[1] The second restriction was included for reasons unrelated to the experiments reported here.

### Subjects

Fifty-four Ss from two fourth-grade classrooms in a semirural Midwestern community were administered the [illegible]. However, due to second-day absences and occasional cases of noncompliance with task instructions, only the data of 43 Ss were analyzed.

## Results

### Subject Classifications Based on the Learning of Pictures and Words

It should be recalled that a primary objective of the present experiment was to corroborate the Levin et al. (1971) finding that an individual's relative performance based on pictures and words was reliable. In the earlier study it had been hoped that some Ss would learn pictures better than words, while the converse would be true for other Ss. However, pictures led to superior learning for almost all Ss, and as a result, classification of learner types was made on the basis of S's picture-word difference being relatively (i.e., as compared with other Ss) large or small. As was argued by Levin et al., this kind of classification procedure created some interpretive difficulties, since with such a system S's performance level and pattern may be confounded. Consequently, an alternative system for classifying Ss was incorporated here.

Ideally, we hoped to identify four different types of learners: (a) Ss who performed relatively well on both pictures and words (Hi P, Hi W); (b) Ss who performed relatively poorly on both pictures and words (Lo P, Lo W); (c) Ss who performed relatively well on pictures but relatively poorly on words (Hi P, Lo W); and (d) Ss who performed relatively poorly on pictures but relatively well on words (Lo P, Hi W). In actuality, however, learners of the fourth type were difficult to find on this task (only a handful out of 288 Ss in the Levin et al., 1971, study and only two out of 43 Ss here). Fortunately, even without such Ss, some interesting outcomes may be anticipated. Consider the Hi P, Lo W Ss, for example. When learning pictures, their performance should resemble that of Hi P, Hi W Ss rather than that of Lo P, Lo W Ss; whereas when learning words, their performance should resemble that of Lo P, Lo W Ss rather than that of Hi P, Hi W Ss. If true, an aptitude by treatment interaction of the kind described by Levin (1972) would be produced, since for some children it is largely a function of the nature of materials (here, pictures or words) which determines whether or not they will display effective learning. The stability of this type of interaction was what interested us here.

To investigate this possibility, we classified Ss according to whether or not they learned relatively well from pictures: those who scored above the mean for pictures were designated Hi P Ss, while those below the mean were designated Lo P Ss. Within the Hi P classification, Ss were divided into two approximately equal-sized groups on the basis of their performance on words (either Hi W or Lo W). As was indicated earlier, when the same criteria for words were applied to Lo P Ss, only two Ss were found to be Lo P but Hi W. The results of these two Ss were not included in the classification stability analysis. Table 1 shows the number of

TABLE 1
MEAN PERFORMANCE ON PICTURES AND WORDS BY THE THREE LEARNER CLASSIFICATIONS (EXPERIMENT I)

| | Hi P, Hi W (N = 12) | Hi P, Lo W (N = 9) | Lo P, Lo W (N = 20) |
|---|---|---|---|
| Form A | | | |
| Pictures | 16.50 | 13.89 | 8.45 |
| Words | 10.25 | 3.44 | 3.50 |
| Form B | | | |
| Pictures | 15.25 | 14.44 | 9.40 |
| Words | 10.17 | 5.44 | 5.40 |

Ss represented by the three learner classifications (Hi P, Hi W; Hi P, Lo W; and Lo P, Lo W), as well as the corresponding picture and word means. Statistical analysis of Form A (the classification list) data revealed significant differences in the three groups' performance on both pictures ($F = 38.42$, $df = 2/38$, $p < .001$) and words ($F = 58.92$, $df = 2/38$, $p < .001$). The nature of these differences varied with the type of item considered, however. Consistent with the desired classification, Scheffé post hoc comparisons ($\alpha = .05$) revealed that (a) on pictures both Hi P, Hi W and Hi P, Lo W Ss differed significantly from Lo P, Lo W Ss, though not from each other; while (b) on words both Hi P, Lo W and Lo P, Lo W Ss differed significantly from Hi P, Hi W Ss, though not from each other.

## Criterion List Performance Based on Initial Classifications

Considering all 43 Ss (including the two Lo P, Hi W Ss), the parallel-forms reliability--based on total (picture plus word) scores on Form A and Form B separated by 24 hours--was found to be .76. Of primary concern, however, when performance on pictures and words was separated according to the initial classification groups, essentially the same pattern was produced as with the classification list itself (cf. Form A and Form B results in Table 1). Statistically, the previously reported results were completely substantiated; that is, based on Scheffé comparisons ($\alpha = .05$): (a) on pictures the performance of Hi P, Hi W and Hi P, Lo W Ss was comparable and different from that of Lo P, Lo W Ss; while (b) on words it was the performance of Hi P, Lo W and Lo P, Lo W Ss that was similar and different from that of Hi P, Hi W Ss.

Until now we have considered only the average performance of Ss in the three classification groups. Of greater interest, however, is whether individual Ss who were classified in a particular way on Form A would have been classified in the same way on a different occasion. To answer this question, we classified Ss according to their Form B performance following the procedures used for Form A. The combined Form A-Form B classifications may be found in Table 2, where it will be noted that 9 out of 12 (75%) Hi P, Hi W Ss, 7 out of 9 (78%) Hi P, Lo W Ss, and 14 out of 20 (70%) Lo P, Lo W Ss were similarly classified on the two occasions. A test of the association in these data (minus the three Lo P, Hi W Ss on Form B) was significant ($\chi^2 = 34.57$, $df = 4$, $p < .001$), with the strength of the relationship as reflected by Cramér's statistic, $\phi'$ (Hays, 1963), being .67.

TABLE 2
CORRESPONDENCE BETWEEN FORM A AND FORM B SUBJECT CLASSIFICATIONS

| | | Form A | | |
|---|---|---|---|---|
| | | Hi P, Hi W | Hi P, Lo W | Lo P, Lo W |
| Form B | Hi P, Hi W | 9 | 1 | 1 |
| | Hi P, Lo W | 1 | 7 | 2 |
| | Lo P, Lo W | 2 | 1 | 14 |

Note: Three Ss who were Lo P, Lo W on Form A would have been classified as Lo P, Hi W on Form B.

## III
## Experiment II

A second (equally important) concern of the present research was that the just-described learner type classifications would relate to performance in learning tasks other than parallel versions of the paired-associate classification task. In particular, reading comprehension was selected as a likely candidate since it has been argued that (a) experimenter manipulations seem to affect paired-associate learning and reading comprehension in similar ways and (b) similar processes may well-underlie each (Levin, 1972).

For example, it is well documented that in a paired-associate task picture pairs are more easily learned than word pairs (cf. Reese, 1970). It has likewise been shown that a pictorial representation of textlike materials is more easily learned than a printed representation of the same materials (Matz & Rohwer, 1971). The same comparison may be made with regard to the role of subject-generated visual imagery in paired-associate learning and in reading comprehension. That is, with relatively concrete materials the generation of imagined visual relationships has been found to facilitate both types of performance (Levin, 1972).

In a recent experiment Levin (in press) demonstrated that while subject-generated visual imagery improves reading comprehension in general, the effectiveness of such a strategy depends largely upon the prerequisite skills of the student. Specifically, fourth graders who could decode and derive meaning from individual words (but could not effectively organize words to derive meaning from sentences) benefited greatly from instructions to generate organizational images on a reading task. As was predicted, however, children who were experiencing decoding and/or vocabulary problems at the word level did not benefit from such an imagery strategy.

An analogy might be drawn vis-à-vis the focus of the present research. Suppose that children are classified according to the system in Experiment I, where it will be remembered that Hi P, Lo W Ss were those children who learned relatively well from pictures but not from words. An intriguing possibility is that their comprehension of textlike (verbal) materials might be improved through the substitution or addition of pictures. On the other hand, this would not be expected for Lo P, Lo W Ss who have difficulty learning from pictures as well as from words.

In this experiment we wanted to see if the three learner type classifications differed with respect to reading comprehension under naturally occurring situations (i.e., in the absence of E-suggested strategies). In addition, however, some of the Ss from each classification group were instructed to employ a visual imagery strategy while reading, with the expectation that only the performance of those Ss who learn relatively well from pictures (that is, Hi P, Hi W and Hi P, Lo W Ss but not Lo P, Lo W Ss) would be enhanced.

### Method

#### Reading Task

Two ten-sentence reading passages appropriate for children of ages 9-12 were constructed following Matz and Rohwer (1971) and Levin (in press). The two passages (one comparing two kinds of monkey and the other, two cars) had been used in previous research reported by Levin and Divine-Hawkins (in press). Each sentence was photographed and mounted on a separate slide transparency. Ten questions based on each passage were constructed to assess comprehension.

#### Subjects

Children from three fourth-grade classrooms in a middle-class Midwestern community participated in the experiment.

## Procedure

Form A of the group-administered learning task from Experiment I was presented to children in each classroom following the procedures previously described. The next day Ss were called out of their rooms individually and were given the two reading passages. Additionally, half of the Ss were given a visual imagery strategy prior to reading the passages. That is, they were told to make up pictures in their minds about what was happening in each story while they read it. The Ss were then provided with a sample sentence (with Ss in the imagery condition given practice in generating images), followed by an oral question about it. The first passage was presented on a slide projector, one sentence every 8 sec. Following the last sentence, E asked the ten questions about the passage in a random order (i.e., the questions, which were typed on index cards, were shuffled anew for each S). No reading was required of S during these oral questions, each of which could be answered in short phrases. The second passage and corresponding questions were then presented in similar fashion. After the second set of questions, E queried S regarding his perceived passage difficulty and his interest in the two passages. The S was also asked to indicate how frequently visual images came to mind while he was reading the passages. Four-point ordinal scales were used to quantify S's responses to each question.[2]

## Results

Subject classifications on the learning task paralleled those of Experiment I and resulted in the identification of 24 Hi P, Hi W Ss, 13 Hi P, Lo W Ss, and 20 Lo P, Lo W Ss. The mean learning of pictures and words by Ss in these groups is presented in Table 3. As was true in Experiment I, these classifications resulted in comparable performance for Hi P, Lo W Ss and Hi P, Hi W Ss on pictures, and for Hi P, Lo W and Lo P, Lo W Ss on words.

Since E assigned Ss randomly to the two reading conditions without knowledge of their particular learner-type classifications, disproportionate numbers of Ss ended up in the two conditions from one learner type to the next, as indicated in Figure 1. In scoring the reading performance data, nothing more than a synonymic deviation from the correct response was accepted. Analysis of the data in Figure 1 (which represent the mean number of correct responses, out of 20, on the two passages) was performed using least-squares techniques for the effects of interest. In order to compare the reading performance of the three learner types under each instructional condition (regular and imagery), learner types were nested within these two conditions.

As may be seen in Figure 1, differences among learner types were small--and statistically nonsignificant ($F = 1.81$, $df = 2/51$, $p > .10$)--for Ss given regular instructions prior

TABLE 3
MEAN PERFORMANCE ON PICTURES AND WORDS BY THE THREE LEARNER CLASSIFICATIONS (EXPERIMENT II)

| | Hi P, Hi W (N = 24) | Hi P, Lo W (N = 13) | Lo P, Lo W (N = 20) |
|---|---|---|---|
| Form A | | | |
| Pictures | 15.58 | 15.00 | 7.25 |
| Words | 12.75 | 4.15 | 3.15 |

[2]Unfortunately, the data derived from these questions were uninformative and therefore will not be discussed further.

to reading the passages. However, when imagery instructions were employed, significant performance differences among learner types were detected ($F = 135.49$, $df = 2/51$, $p < .001$). Scheffé post hoc comparisons ($\alpha = .05$) confirmed the visual impression obtained from Figure 1: Hi P, Hi W Ss and Hi P, Lo W Ss each differed significantly from Lo P, Lo W Ss, though not from each other.

As a main effect, imagery instructions were not facilitative ($F < 1$), the explanation of which may be inferred from Figure 1: While the performance of good picture learners (Hi P, Hi W Ss and Hi P, Lo W Ss) exhibited a descriptive improvement when imagery instructions were employed, the performance of poor picture learners exhibited a descriptive decline. A further consideration of this result is given in the following section.

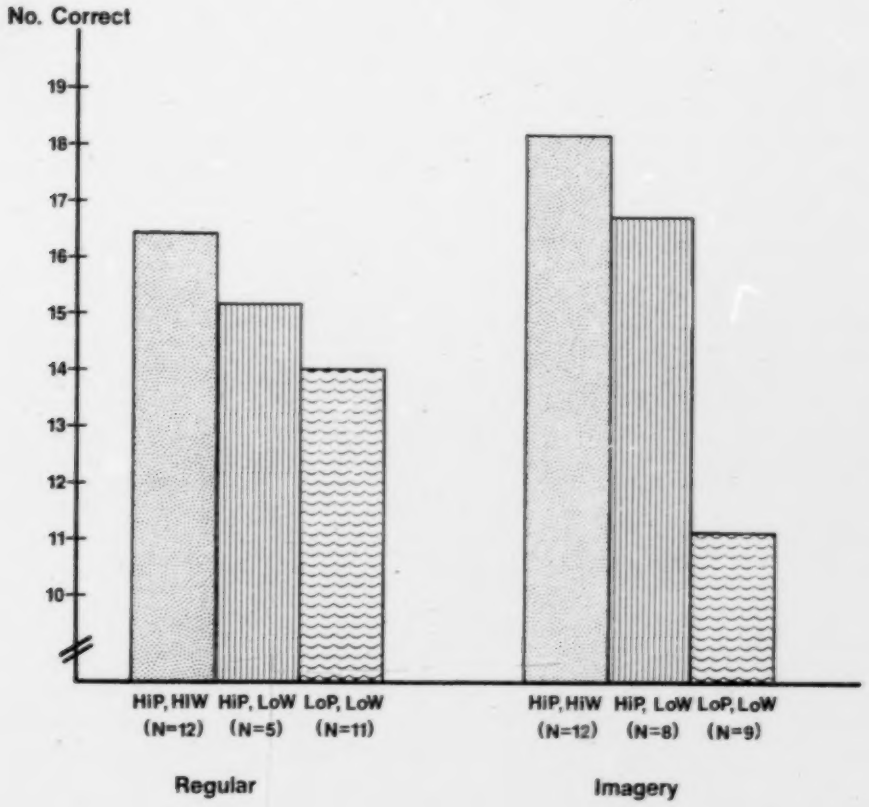


Fig. 1. Mean performance on the reading task by the three learner types under different instructional conditions.

## IV
## Discussion

By approaching the "learner types" problem in a manner different from that of Levin et al. (1971), in Experiment I we were similarly able to detect reliable individual differences in children's ability to learn pictorial and verbal materials. Some children learn both well; some learn both poorly. However, for many children whether they are regarded as learners or nonlearners depends on whether the materials are pictures or words. It is for just these children that previous discussions of ordinal aptitude by treatment interactions are relevant (Levin, 1972; in press).

Psychometrically speaking, it is important to note that the classifications of Experiment I were sufficiently potent to overcome the counteracting influences of statistical regression (on Form B). Practically speaking, it is also important that learner-type diagnoses may be couched within a group-administered task. At the same time, one should not lose sight of the fact that the Experiment I data are based on only a 24-hour separation. It would certainly be fruitful to determine the limits of the instrument's long-term stability.

In Experiment II we capitalized on the learner-type classifications to assess a child's performance on a reading task. While minimal differences among groups were discovered on the reading task per se, when a visual imagery strategy was induced in the children prior to reading, substantial differentiation among learner types was observed. What we found was that children who do not learn appreciably better from pictures than from words (Lo P, Lo W Ss) did not benefit as much from the imagery strategy as those who do (Hi P, Lo W Ss). In fact, as Figure 1 suggests, imagery instructions may well have been detrimental to the reading comprehension of Lo P, Lo W Ss. Assuming that such Ss have developed alternative (nonimagery) strategies for successfully processing prose materials under natural conditions (cf. the bars to the left in Figure 1), this result is not totally surprising.

Just as it has been previously demonstrated that children first must comprehend individual words before they can use visual imagery to their advantage while reading (Levin, in press), the present research adds to this finding by suggesting that certain learning modality by reading strategy interactions may also have to be considered. Of late, visual imagery has been heralded as an effective organizational strategy for relatively concrete prose materials (Levin, 1972). However, when its success clearly depends on the capabilities of the user, caveats about its nonuniversality cannot be echoed too loudly.

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